N94-16357

CHONDRITIC RATIOS OF Fe/Cr/Ir IN KERGUELEN PLATEAU (HOLE 738C) K/T CARBONATE-RICH SEDIMENTS SUPPORT ASTEROID-COMETARY IMPACT AT K/T TIME; **Y.G. Liu[1,2] and R.A. Schmitt[1-4], [1]The Radiation Center and Departments of [2]Chemistry and [3]Geosciences, and [4]College of Oceanography, Oregon State University, Corvallis, Oregon 97331**

In the study of marine carbonate sediments from Holes 577 and 577B, Shatsky Plateau (Rise), a net extraterrestrial Fe/Ir = C1 chondritic ratio at the K/T boundary was reported [1]. Applying a similar procedure to Hole 738C (Kerguelen Plateau) data reported by [2], we obtain Fe/Cr/Ir ratios similar to C1 or C2 chondritic ratios.

Hole 738C data were normalized to Th. Because Th is very low in seawater, $\sim 3\pm 2 \times 10^{-5}$ μg/L [3,4], little if any Th precipitated from seawater onto the detrital clay, and therefore, Th is an excellent diagnostic clay indicator. (Scandium was used as a normalization element by [2], none of which involved Fe/Cr/Ir calculations. Because ~77-86% of the total observed Sc is precipitated from the overlying $\lesssim$300m of seawater, normalization to Sc is invalid as a detritus indicator.) Using Th-normalized data, the net extraterrestrial ratio Fe_{ext}/Ir_{ext} can be calculated by integrating under the total peaks and subtracting the terrestrial ratios.

$$\frac{\sum_i (Fe_{tot} / Th_{tot})_i - (Fe_{ter} / Th_{ter})_i}{\sum_i (Ir_{tot} / Th_{tot})_i - (Ir_{ter} / Th_{ter})_i} = \frac{\sum_i (Fe_{ext} / Th_{ter})_i}{\sum_i (Ir_{ext} / Th_{ter})_i} = \frac{Fe_{ext}}{Ir_{ext}}$$

where $\sum_i$ is the summation of all ith intervals over the total peak. In the above equation, Fe_{tot}, Ir_{tot} and Th_{tot} are total amounts in the sample; Fe_{ext} and Ir_{ext} are extraterrestrial (e.g. cometary or asteroidal ejecta fallout etc.) in the samples. The above equations are valid because $Th_{ter} >> Th_{ext}$; therefore, $Th_{tot} = Th_{ter}$; e.g. Th_{ter} = 12.3 ppm in North American Shale Composite (NASC) [5], and Th_{ext} = 0.03 ppm in C1 chondrites [6]. Also because Th_{ter} values fluctuate, the final equation over the entire peak is valid only if Fe_{ext}/Ir_{ext} = constant in all of the ith intervals. Similar equations are obtained for Fe_{ext}/Cr_{ext}.

We obtain the results that $Fe_{ext}/Ir_{ext} = 4.5\pm1.1 \times 10^5$ and $Fe_{ext}/Cr_{ext} = 85\pm21$, which are the same as found in C1 and C2 chondrites. For C1 chondrites, Fe/Ir = $4.0\pm0.3 \times 10^5$ and Fe/Cr = 72 [6].

The agreement for the net Fe/Cr/Ir ratios between Hole 738C data and C1 chondrites suggests that all three elements were precipitated as their insoluble oxyhydroxides onto clay detritus and carried to the 738 site as well as from direct fallout over the 738 site at K/T time. Now at two very different oceanic K/T sites, one at the Shatsky Plateau (Rise) (~12°N at K/T time) in deep (>1800m) seawater near the west central Pacific and the other on the Kerguelen Plateau (~60°S at K/T time) in seawater at ≤ 300m, we have found net $(Fe/Ir)_{ext}$ = C1 chondritic ratio. This strongly supports either the L.W. Alvarez asteroidal [7] or the H.C. Urey cometary [8] impact hypothesis and our previous observation [1] that C1 Fe/Ir in the vaporized impactor ejecta fallout were C1 or C2 as were eight other elements at selected sites (see #5 in [9]). The results are remarkably similar to those obtained by computer simulations [10].

We have used our Shatsky Rise Hole 577 data to calculate the $(Fe/Ir)_{ext}$ and $(Fe/Cr)_{ext}$ at the K/T boundary in the same manner as for Hole 738C data. We found that the $(Fe/Ir)_{ext} = 4.4\pm0.9 \times 10^5$ ratio agrees with the C1 ratio within error. The $(Fe/Cr)_{ext} = 260\pm30$ is ~3.6X higher than the C1 ratio, indicating a lesser amount of Cr was carried along with the Fe from the impactor ejecta fallout. If we follow the same calculational approach, i.e. normalization to Th by using the L.B.L. data [11] for the Shatsky Rise Hole 577B, we obtain $(Fe/Ir)_{ext} = 6.6\times10^5$ and $(Fe/Cr)_{ext} = 290$. Perhaps the higher $(Fe/Ir)_{ext}$ ratio could be explained by their use of "standard pottery" as the Fe standard. But when we used a relative background subtraction method as outlined in [1] which eliminates possible errors in an analytical standard, we obtain from their Hole 577B data $(Fe/Ir)_{ext} = 3.4\pm0.6 \times 10^5$ and $(Fe/Ir)_{ext} = 4.0\pm0.3 \times 10^5$ for our Hole 577 data. The higher $(Fe/Cr)_{ext}$ ratios at Holes 577 and 577B could be interpreted in terms of the higher Ksp of $Cr(OH)_3$ by nine magnitudes relative to $Fe(OH)_3$, i.e. less coprecipitation of $Cr(OH)_3$ with $Fe(OH)_3$, both of which are assumed to be present in C1 ratio in the vaporized ejecta fallout [10].

We obtained a higher $(Fe/Co)_{ext}$ ratio of 1330 relative to a C1 ratio of 380, which indicates that ~29% of the Co from the impactor C1-like ejecta fallout was carried or deposited directly at the site 738C relative to Fe/Cr/Ir. We attribute the small fraction of coprecipitated Co from the impactor fallout to the very different seawater chemistry of Co relative to Fe, Cr, and Ir. Using the latest solubility values for Fe and Co in seawater, it is estimated that the residence time of Co is ~200X greater than that of Fe in seawater. Also we found essentially no net impactor signals from Ni and Co at the K/T boundary on the Shatsky Rise (see Table 1 in [1]) because the Ni/Al and Co/Al ratios for K/T boundary samples agreed within errors with the corresponding ratios in the trace elements peaks before and after the K/T trace element peaks. The reason no Co peak was observed in the Shatsky Rise K/T boundary is attributed again to its much longer residence time and to the deep oxic Pacific regime relative to the different regimes in the intermediate seawater depths of ≤ 300m over the Kerguelen Plateau, where we observed ~29% of relative impactor Co.

Iridium in Hole 738C exhibits an asymmetrical peak with a gradual tailing upward. If we assume a Gaussian dispersal because of a little bioturbation (the presence of extensive bioturbation has been ruled out by [2] because of the presence of sedimentary laminations), then a FWHM of ~0.8 cm seems apparent, thereby yielding ~21 ng/cm^2 of Ir. The total Ir found at 738C is ~270 ng/cm^2 according to our calculation. Therefore only ~8% of the total Ir deposited at 738C is direct impact fallout and ~92% originates from fluvial sedimentary input and/or later turbidity currents.

Because the lamination formation probably was derived from local provenance a time interval for deposition of ~10^3-10^5 years after K/T was estimated [2]. The smaller value of ~21 ng/cm^2 of Ir for higher K/T latitudes of ~60°S is now more in line with ~71 ng/cm^2 of Ir found at the Shatsky Rise (~12°N). If the main impact occurred between 30°S to 30°N, one would expect more global impactor ejecta fallout between 30°S-30°N relative to ~60°S or ~60°N.

References: [1] Jin Y.-G. and Schmitt R.A., (1989) L.P.S. XX, 460-461, 462-463. [2] Schmitz B. et al. (1991) O.D.P. Scientific Results, 119, 719-730. [3] Huh C.-A. et al. (1989) G.C.A. 53, 1357-1366. [4] Lee T. and Chen J.H. (1988) E.A.G. Int'l Conf., Paris. [5] Gromet L.P. et al. (1984) G.C.A. 48, 2469-2482. [6] Anders E. and Ebihara M. (1982) G.C.A. 46, 2363-2380; Anders E. and Grevesse N. (1989) G.C.A. 53, 197-214. [7] Alvarez L.W. (1980) Science 208, 1095-1108; Hut P. et al. (1987) Nature 329, 118-126. [8] Urey H.C. (1957) Nature 179, 556; (1962) Science 137, 746; (1963) Nature 197, 228. [9] Schmitt R.A. (1990) L.P.S. XXI, 1085-1086. [10] Roddy D.J. et al. (1991) L.P.S. XII, 1129-1130. [11] Michel H.V. et al. (1985) Init. Repts. Deep Sea Drilling Project 86, 533-538.